

Status of Jason-3 and follow-on

The Jason-3 mission is a joint effort among four organizations: NOAA (National Oceanic and Atmospheric Administration), EUMETSAT (European Organisation for the Exploitation of Meteorological Satellites), CNES (Centre National d'Etudes Spatiales), and NASA (National Aeronautic and Space Administration), to measure sea surface height by using a radar altimeter mounted on a low-earth orbiting satellite. The collection of precise measurements of sea surface height is essential for ocean climatology and ocean weather applications. Ocean climatology includes global sea-level rise, a key indicator of climate change, decadal variability in the ocean, seasonal/inter-annual variability, and coastal variability and its impact on ecosystems. Ocean weather involves operational oceanography, surface wave forecasting and evaluation, and hurricane intensity forecasting.

The Jason-3 mission will ensure the continuity of the 20 plus year data record started with TOPEX/Poseidon in 1992 and continued with Jason-1 and 2. The launch of Jason-3 is planned in Q2 2014 with a 6-month overlap with Jason-2. The overlap period will be used to conduct initial cross-calibration and validation activities, complete on-orbit check-out operations, and maintain consistent observations of sea surface height between the successive altimeter missions.

In order to ensure continuity of these key measurements over the next 15 years, discussions have been initiated between potential Partners in Europe and in the US on a new programme named Jason CS (Continuity of Service). The satellite should be based on the Cryosat 2 bus, an industrial Phase B1 has been kicked off in fall 2010 to analyze and assess the modifications from Cryosat 2 to Jason-CS. The programme will be based on at least two satellites, the first one being launched in 2017 covering the time span before a new technology can eventually become operational.

This paper presents the status of the Jason-3 Programme development and on the current Jason-CS activities.

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1 INTRODUCTION

The Jason-3 mission is a joint effort among four organizations: NOAA (National Oceanic and Atmospheric Administration), EUMETSAT (European Organisation for the Exploitation of Meteorological Satellites), CNES (Centre National d'Etudes Spatiales), and NASA (National Aeronautic and Space Administration), to measure sea surface height by using a radar altimeter mounted on a low-earth orbiting satellite. The collection of precise measurements of sea surface height is essential for ocean climatology and ocean weather applications. Ocean climatology includes global sea-level rise, a key indicator of climate change, decadal variability in the ocean, seasonal/inter-annual variability, and coastal variability and its impact on ecosystems. Ocean weather involves operational oceanography, surface wave forecasting and evaluation, and hurricane intensity forecasting.

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2 Jason-3 development status

2.1 System and ground system

At system level, the main activities relates to the preparation and conduct of the so called "System Synthesis Design review" (SSDR) that was held beginning of February 2011.

The satellite contract has been kicked off in March 2010, and the PROTEUS platform is now fully integrated and tested. No issues have been revealed and the platform has been stored up until that start of payload activities. Some periodic (every 6 month) destorage activities will take place. The European instruments, altimeter and DORIS are also in development and scheduled for a delivery for integration on the satellite bus respectively in July and in April 2012.

The ground segment development activities have been started by all partners.

Several Jason-3 Ground system meetings were held and addressed:

- The system activities linked to the Jason-3 ground system;
- The development status of each partner;
- Jason-3 Operations Service Specification (OSS);
- Jason-3 Ground System Requirements, Architecture and Operations Concepts, (RAOC);
- Jason-3 Ground System Interface;
- Jason-3 specific features and challenges.

The Jason-3 ground segment architecture will look very similar to Jason-2, with the addition of two Earth Terminals (one in Usingen in Europe and one in Barrow in the US). The data communication network will also be increased to allow both Jason-2 and 3 data flows.

There will also be a maximum reuse of Jason-2 software by all partners and this will result into a very high level of commonality in operations, with the two missions eventually operated by the same systems. As a consequence, the operational merging strategies will need to be clearly defined and validated. This validation will take place as part of the Jason-3 validation even if the merging of Jason-2 and 3 systems is only foreseen after the end of the Jason-3 commissioning period.

The Eumetsat Jason-3 ground segment design has been reviewed with the partners during a key point early July 2011. This will allow starting the procurement and preparing the compatibility tests. The system test will then be started when all partners would have completed their own internal development and tests.

2.2 Schedule

The initial schedule has been affected by two events on the US side, first the Continuing Resolution impacting the available 2011 budget for NOAA/NASA and second the failure of the last Taurus XL launch impacting the launcher selection process and date.

The project teams at 4 partner level has consequently worked a replan taking into account the reduced available budget on the NOAA/NASA side for 2011 and the delay in the launcher selection. The project looks at a compromised funding allocation between the launch vehicle and the instruments to minimize the overall mission impact. The satellite Assembly, Integration and Test (AIT) activities have been optimized such as to minimize cost impact and make the most effective use of the industrial team. The overall delay in the delivery of the US instruments is of about 5 months. In order to avoid an interruption in the payload and satellite activities, the start of the payload AIT has been moved accordingly. Keeping the same duration of AIT phases and also the same system margin, lead to a launch date by April 2014. This updated replan and associated schedule has been presented to a 4 partner Joint Steering Group (JSG) on June 30th 2011 and has been endorsed by the JSG.

3 Jason-CS status of activities

3.1 Programme Priorities and Constraints

The priorities are:

- The continuity to operational reference high accuracy Radar Altimetry line, i.e. Jason;
- A balanced work share in Europe in the implementation of the post-Jason reference altimetry mission;
- The consideration of the CEOS altimetry constellation User Requirement Document by all parties;
- The affordability and long-term sustainability of the programme with secured resources;
- The continuation of the US-Europe cooperation.

The constraints to be taken into account are:

- The need for first post-Jason-3 mission to be launched by 2017/2018 in order to ensure adequate overlap with Jason-3, taking into account the changes between both systems and the need for precise inter calibration between both;
- The parallel approval of the programme by all partners in 2012/2013;
- Currently as a minimum 2 missions need to be foreseen, i.e. JCS-A and B with possible lifetime of 7.5 years for each mission allowing 15 years of overall lifetime, before demonstrated new technologies can eventually be embarked on operational missions.

Finally EUMETSAT has also stressed that its participation to the Programme would be linked with the 3 further constraints:

- (1) the continuation of the cooperation between US and Europe in this domain,
- (2) the conduct of satellite operations at EUMETSAT and
- (3) the need of taking benefit from the existing system expertise of CNES in the field.

It is the objective of the Secretariat to ensure a maximum of synergy within EUMETSAT between Sentinel 3, the Jason2/3 series and Jason-CS. To this end and even if this remains to be discussed in detail with the partners and further translated into cooperation agreements, the role of EUMETSAT in Jason-CS should be build around the following lines:

- (1) Co-leadership of the programme with ESA and NOAA;
- (2) Design, develop and validate the European part of the ground segment;
- (3) Conduct satellite operations at EUMETSAT after the completion of the LEOP phase;
- (4) Perform (together with NOAA at least for the NRT products) data processing up to level 1b or 2 products;
- (5) Coordinate with the partners the Science/Operational monitoring of the mission including CAL/VAL and ensure user interface service.

3.2 Status of Phase B activities

The Jason-CS satellite will be based on the Cryosat 2 satellite bus that was successfully launched in April 2010 and which ended up its commissioning phase by a validation review at the end of October 2010. But even with this strong heritage, the transition from Cryosat 2 to Jason-CS implies a number of modifications or adaptations which need to be analyzed in detail before starting the development phase.

This is the objective of the industrial phase B1 which have started by ESA in November 2010. Among the various activities to be performed, the accommodation of a new set of instruments is a key issue. The SIRAL altimeter from Cryosat-2 will be replaced by an equivalent instrument dedicated to the ocean.

There is also a need to add a microwave radiometer (US or European) to correct the altimeter path delay from the wet troposphere effects and the Precise Orbit Determination set of instruments (DORIS, GPS US or European and Laser) needs to be analysed in detail. Furthermore, these changes of payload instrument and also the change of orbit will impact several of the platform subsystems (power, thermal, AOCS, propulsion etc.).

The phase B1 is planned to last up until early 2012 and as already indicated above, the partners NOAA/NASA and CNES are associated to this process.

Regarding the orbit choice, EUMETSAT has conducted two parallel studies in 2009/2010 to investigate alternative orbits to the 1336 Km orbit used for Topex and the Jason series. The synthesis report of both studies has been shared with the OSTST in July 2010 and a dedicated session has been organized on this topic during the last OSTST meeting in Lisbon in October 2010 where a clear recommendation was requested to the OSTST community.

Furthermore, it was recognized that the cal/val issues related to a change in orbit in the context of the climate record would need to be investigated in detail. ESA also highlighted that there are very strict requirements on de-orbiting Earth observation missions.

Through this analysis process and after consultation of all the OSTST sub groups and a plenary session discussion, the following recommendation was adopted by the entire OSTST: *“Given the overriding importance of maintaining the precise climate record of sea surface height, the challenges of calibrating and validating without formation flying between Jason-3 and Jason-CS, and the lack of a clear and net scientific benefit of a change of orbit, the OSTST recommends that Jason-CS maintain the 1336 Km reference orbit flown by TOPEX/Poseidon and Jason-1, 2 and 3”*.

This recommendation has been taken into account in the phase B1 activity. The main impacts are:

- The need to embark a substantial amount of additional propellants to comply with the debris mitigation requirement of a natural de-orbitation within 25 years. Industry has already confirmed the feasibility, but the detailed analysis (tank accommodation etc...) is planned during Phase B1.
- The need of a detailed radiation analysis to evaluate the total dose received at electronic parts level after 7.5 years (extended life time) and to compare it to the parts tolerance.

- The goal is to quickly identify the need for additional shielding or to find alternative parts.

Several progress meetings have been held in 2011 with participation of the industrial consortium and all agencies (ESA, EUMETSAT, NOAA, NASA, and CNES).

Various payload accommodation options have been presented and the compatibility with the fairing volume of the potential launchers will need to be now assessed in more details.

Compatibility has to be ensured with various US launchers (Falcon 9 and Taurus 2 at least) and with VEGA, the fairing volume of the last one being the most constraining. This would imply the use of partly deployable solar array.

At satellite system level, an important trade off option is also the use of the high resolution along track (SAR) mode and on which areas (open ocean or coastal zone only) it would be used. This impacts the power needs and the data rate with possible need of on board processing and compression. In parallel with the flight segment study, an analysis of the user needs and benefits of SAR mode will be done. One promising feature would be to have both the Low Resolution Mode (LRM) and SAR mode working simultaneously in a so-called interleaved mode and to receive both data sets.

EUMETSAT also has the action to investigate the possibility to include radio occultation as a secondary mission. This should take into account the possible location of additional GPS antenna (located on the front and/or rear of the satellite) and the specific occultation geometry from the specific Jason-CS orbit (1336 Km, 66° inclination). Further analysis will be done during Phase B1 before a formal recommendation is formulated.

The next step is a Detailed Concept Review (DCR) that will be held in fall 2011 with the objective to review the definition status, assess the various options considered at satellite and payload level so as to narrow down the number of these options and focus the second part of the Phase B1 on the remaining open points.

4 Conclusion

The development of the Jason-3 program is progressing as planned from the engineering point but is impacted by programmatic issues that have led to a shift in the schedule with a launch now planned in April 2014.

As the Jason-2 satellite and system is today in perfect shape with all redundancy still available after 3 years in the mission, there is a very good hope that an extension of Jason-2 beyond the planned 5 years mission lifetime will be possible. Moreover, it should preserve the overlap period between Jason-2 and its successor, during which both system will be accurately cross-calibrated.

In order to ensure continuity of these very important high accuracy altimetry data and product delivery, EUMETSAT and ESA, together with CNES and NOAA, have taken initiatives to define a new Programme, Jason-CS, based on two satellites, covering the 15 years time span before new technologies can be considered on an operational altimetry mission.